BOSTON UNIVERSITY

GRADUATE SCHOOL

Thesis

AN EXPERIMENTAL TEST OF THE SEASHORE "MEASURES OF MUSICAL TALENT"

Submitted by

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p 6417

CONTENTS

CONTENTS

INTRODUCTION

1.Development of vocational tests in music. As early as 1890 Stumpf[1] proposed four tests of musical capacity,one being the ability to discriminate between two tones of different pitch.Seashore[2] in 1901 suggested certain thresholds of pitch discrimination as the criterion by which to advise the selection of those who could profit by musical training.Hughes[3] in 1902 found that of a choir graded into three classes according to their estimated musical ability,the best group had the highest average sensory acuity in pitch discrimination.This is one of the first of the few attempts to use correlations in musical talent tests.In 1909 Stucker[4] measured members of the Royal Opera in Vienna and found that they had better discriminatory ability in pitch than did non-musicians.Rupp[5] in 1914 set forth eight criteria for the proof of musical ability,and Révész[6] in 1916 started to study a boy prodigy and in 1920[7] published an inventory of musicality based on this study,together with the results of his tests on six-three school children.He found the ability to sing heard melodies the test "par excellence". As the result of his researches at the University of Iowa,during the past nineteen years,Seashore[8] published a long inventory of tests which he considered measured components of musical talent. He considers the six tests of fundamental abilities to be:(1)the sense of pitch, (2)the sense of time,(3)the sense of intensity,(4)the sense of consonance,(5)the sense of rhythm,and (6)the tonal memory span.

[1]TONPSYCHOLOGIE. Leipzig 1890,p.157.
[2]"Suggestions for Tests on School Children",Ed.Review,1901,22,p.76.
[3]"Methods of Testing Relative Pitch",Psychol.Review,1902,9, p.603ff.
[4]"Über die Unterschiedsempfindlichkeit für Tonhöhen in Verschiedenen Tonregionen",Zeit.f.Psychol.,1908,42,392-408.
[5]"Über die Prüfung Musikalischer Fahigkeiten",Zeit.f.ang.Psychol., 1914,9,p.404ff.
[6]ERWIN NYIREGYHAZI. Leipzig 1916.
[7]"Prüfung der Musikalität",Zeit. f. Psychol.,1920,85,163-209.
[8]PSYCHOLOGY OF MUSICAL TALENT. Boston 1919,p.7.

These tests are recorded, and can be purchased from the Columbia Gramophone Co. with instructions for using them.As the Seashore tests have been most frequently used,this paper will consider them,only. The test of rhythm was not used in this investigation because the record has not been available in England for the past year.

2.Purpose of Seashore tests.The initial purpose of the tests is the discovering of musical talent.If they are valid indices of musical talent,than a general survey of all children in the grade schools should disclose which children should be given the opportunities of a musical education.Where exceptional ability is found,it should be encouraged,and individuals,whose abilities fall within the lower limits,should be advised not to attempt to make music their profession.Much time,money,and later disappointment would be saved many individuals who,being poorly equipped, still continue to struggle for recognition,and live in hopes of success,when really there are no hopes.On the other hand there are many who are doubtful of their abilities and only need assurance that they possess them,to keep them from becoming discouraged and quitting.There is scarcely any other profession in which one needs to start so early and work so diligently as in music.Consequently one cannot afford to wait the normal time necessary to make a mature musician,usually ten to twenty years, to see if they have the talent,as then it is too late to prepare for other professions, in case of failure in music.Some method of prognosis is highly desirable to select those who can profit by musical training so they can begin their training early enough to ensure success.

3.Some criticisms.There have been several notes of dis-

satisfaction regarding the accuracy of measurement of these "Measures of Musical Talent," the most serious one being that they do not measure this talent at all. It is argued that musical feeling and imagination are the chief factors for a musician to possess in order to attain success, and these tests take no account of them. Others have been that a person, lacking all the "senses" as measured by the tests, might still be a good musician, and any attempt to use them as the basis of selecting musical talent would be doing some musical individuals an injustice. Inasmuch, "as the results are computed on the theory of chance"[1], and as the difference of one mistake will, in some cases, make a difference of seven points in the final ranking as computed from the standard of a normal community, determined by Henry M. Halverson and Hazel M. Stanton[2], the normal variation of the factor of chance would operate to make the final results more or less inaccurate. These criticisms, and others which will be brought up later, are the reasons why the present research was undertaken.

PURPOSE OF THE RESEARCH

1. Validity of Seashore tests. The present investigation is an attempt to determine by experiment if the tests are sufficiently measuring the talent they purport to do, and if what they do measure is a constant and necessary factor for such a talent to attain success. In other words, can musical talent be analysed into different elements and then, after measuring each element, and pooling the results, a judgment be made of the whole? If the tests are not measuring what they were intended to measure, we should know

[1] C. E. Seashore, "Manual of Instructions and Interpretations" Columbia Gramophone Co., 1919, p. 7.
[2] "A Survey of Musical Talent in the Public Schools", Uni. of Iowa Studies, 1920, 1, No. 2.

that fact so they will not be given and taken seriously for vocational guidance.On the other hand if they are valid tests they should be used freely and generally.

2.Operation of chance. Assuming that the tests are valid discriminators of talent,then from their construction,we would be interested to determine what effect the direction,"If the listener cannot hear the effect called for,he must guess,as the results are computed on the theory of chance"[1],has upon the final interpretation. In some parts the tests are graduated so minutely that no one can get them all right,and from the directions some decision must be made,and that on the basis of a guess.How great this factor is should be determined in order to know if this is a fundamental fault of the tests.

3.Advisability of use. The final purpose is to obtain results which will be reliable to use in advising whether these tests should be used for the purpose for which they were devised.

METHODS

1.Experimental treatment. The tests are to be given to one,or more,groups of persons who, either are not musicians,or are not proficient in performance.This general group of non-musicians is then compared with the results obtained from giving the same tests to selected groups of young artists,most of whom have already distinguished themselves in performance.The first group is composed of university students, and the second of students from two conservatories and a famous piano school in London. In computing the factor of chance, the subjects were given the same form blanks

[1]C.E.Seashore,"Manual of Instructions and Interpretations",p.7.

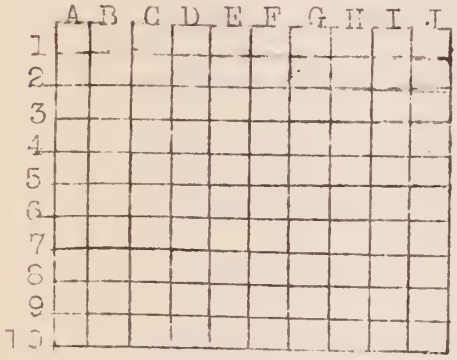
to fill out as they used during the actual test, a sample of which is given on page eight, and were directed to fill in the blanks with the same symbols (H and L) used in the actual test. As the subjects had nothing else to guide them in completing the forms, the latter were filled in solely by chance. Only the test of pitch is treated this way, but the other tests are constructed on the same principle, and we should expect to find the same results in all the other tests.

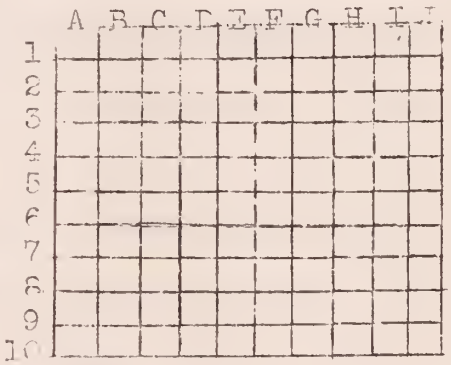
2. Statistical treatment. In all the groups the actual average was found, and the standard deviation and standard error computed. The range was of course evident. One group was compared to another on the basis of the average, range, and measures of deviation. The significance of the difference in the averages of two groups was calculated to determine if it was due only to chance. The Pearson product-moment formula for finding the coefficient of correlation was used in finding the correlation between pitch discrimination and number of years musical education. In the test of pitch the percentage of mistakes in each series of ten trials was found, to find where the test was hardest, and to determine if chance in this part alone was unduly influencing the score. The actual calculations made for each test are given at the end of the discussion of each test.

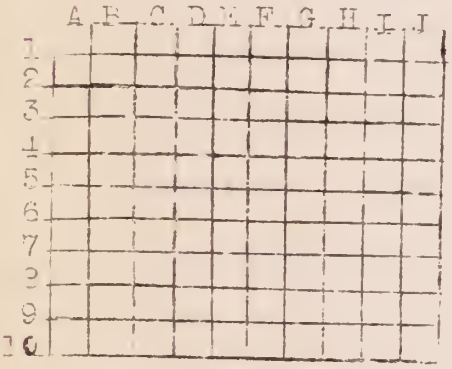
3. Analytical. The structure and content of some of the tests are discussed, together with references to other work on the same subjects, but this is not a part of any proof offered in this research.

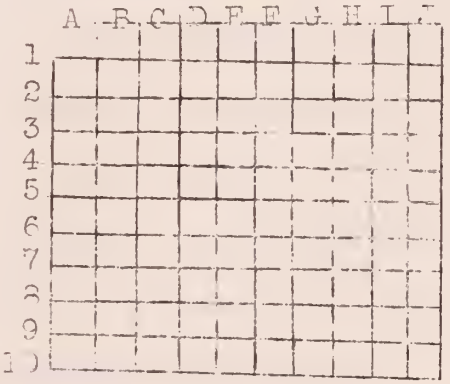
4.Procedure. The New England Conservatory group consisted of men and women from twenty to twenty-three years of age,all of whom had studied voice,piano,violin,or cornet for three or more years and were third year students at the conservatory. The subjects were from a normal training class,and although not all professional players yet,they were all good musicians. The tests were administered in a room approximately 15x25 feet,on a Columbia Grafanola of the school type manufactured by this company.The needles used in all the experiments were hard steel, loud tone quality,and every phonograph used was set for 78 revolutions per minute.For this group the phonograph stood on a platform eight inches high. All of the groups were given the directions from the "Manual of Instructions and Interpretations" by Seashore,and were allowed from two to four demonstrations of the A side of the disc to become familiar with the nature of the test,and to completely understand what was required of them.This group was given all six of the tests in a period of two hours. The Matthay School group consisted of piano students at this famous school in London,and contained many good young artists already distinguished for performance. The tests of pitch,time,and tonal memory,were given in the lecture hall of the school,a room about 30x50 feet,and the Cliftophone gramophone was on a platform two feet high. The test of intensity was given to the same group one week after the above three.The test of consonance was given in two sections, six cases in the lecture hall of the Matthay School,and the remainder in a smaller room about 10x12 feet with a Parlorphone gramophone,concert grande model. The Royal Academy of Music group for the tests of intensity and consonance,was from a third year

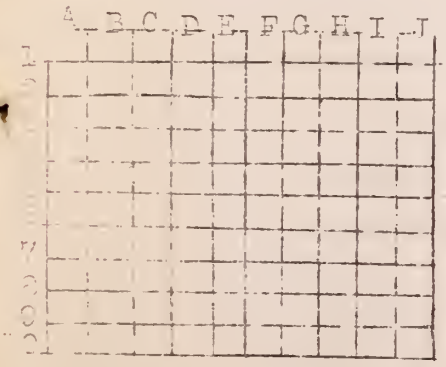
class in aural training and represented the best students of the institution; all were men or women from eighteen to twenty-nine years of age, and students of voice or piano, (and some played alternate instruments such as 'cello or violin). The tests were given in a room approximately 30x50 feet, and the His Master's Voice gramophone(cabinet style) was on the floor. The test of tonal memory was given under the same conditions, but to a class in first year aural training and consequently was not as good a selection of talent as the third year students, but they had studied music three or more years, were from seventeen to twenty-two years of age, and played piano; 'cello, violin, or sung. The college groups all came from general psychology classes at Boston University. Groups A and C were given in Jacob Sleeper Hall, a room approximately 50x100 feet, and the small model A Victor phonograph was placed on the platform which was three feet high. The subjects all sat within easy hearing distance in a small group. Group B was given in room 62 which is about 30x60 feet and the same Victor phonograph was on a platform about a foot high and placed on a table. Although the conditions as to time, place, and phonograph, varied from group to group, it is doubtful if the results are in any way less reliable because of them. The conditions of all experiments were made as nearly alike as possible for each group, such as needles, rate of speed for the phonograph, directions, and demonstration, and were all under the observation of the same experimenter in all cases. Comparisons between groups were always made on the basis of the rank scores, given in the manual, and not on the raw score of each test.

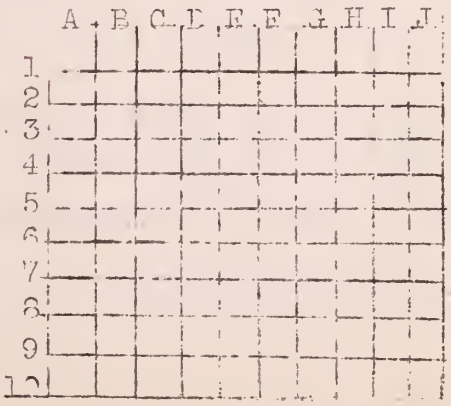












Name ______________________ Age ______________

Musical Education ______________
(grade, or number of yrs.)

Instrument or voice ______________

Appreciation ______________
(jazz, classical, or none)

Parents' Musical Ed. father ______________
mother ______________
ancestor ______________
(what instrument, degree of proficiency

Test ______________ Score ________

	A	B	C	D	E	F	G	H	I	J
1										
2										
3										
4										
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6										
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8										
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Test ______________ Score ________

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Test ______________ Score ________

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Test ______________ Score ________

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COMPARISON OF MUSICAL AND NON-MUSICAL GROUPS

PITCH

1.New England Conservatory group compared with college groups. The instructions given for this test were,"You will hear two tones which differ in pitch.You are to judge whether the second is higher or lower than the first.If the second is higher record H;if lower, record L."[1] In this comparison of scores for pitch discrimination between selected groups of musicians and general groups unselected for musical talent,we will consider the average,the range,the standard deviation,and the standard error.From Tables 1 and 11 we find that the average for the musical group is 78.6 as compared to an average of 45 for the non-musical group.The range for the first group is 55 and does not go below a score of 45,while the second group has a range of 93 beginning with score 1. The lowest score for the musical group represents the average score of the general group.The first has a S.D.(standard deviation)of 17.45 while the latter is as large as 27.55.The reliability of the measures of deviation expressed in S.E.(standard error)of 4.76 and 5.6 respectively,show that both measures are approximately of the same reliability.This great difference between the groups,then, represents either a difference of natural ability,or of training, and the test has fairly accurately differentiated between these two groups.The question as to whether this difference observed is due to training or to inherent ability seems to have been decided by an experiment on school children by Seashore[2] and Smith[3]

[1] C.E.Seashore,"Manual of Instructions and Interpretations",p.9.

[2] "The Measurement of Pitch Discrimination",Psychol.Monog.,1910,13, No.53.

[3] "The Effect of Training in Pitch Discrimination",Univ.of Iowa Studies in Psychology, 1914,6.

who conclude, "ordinarily musical education is not effective as a means of improving pitch discrimination" [1].We are then to conclude that the difference recorded and measured by this test is one of ability,and that this test is a fairly reliable measure of this ability.

In order to verify our findings with the above two groups we will take two more unselected groups to compare with the musical group.The unselected group already considered is known as Group A,and the two to be considered now will be called Group B and Group C respectively. All unselected groups used for this test are composed of sophomores and juniors from elementary classes in psychology at Boston University College of Liberal Arts. The selected group has already been described as a class taking a normal training course at the New England Conservatory of Music in Boston. In Group B with twenty cases there is an average of 59.5 which is considerably higher than the average of 45 obtained for Group A. This average is however still significantly lower than that of 78.6 received by the New England Conservatory group. The standard deviation and standard error is practically the same as for Group A,but the range is somewhat smaller,being 77 as compared to 93.

Taking the last unselected group,Group C, for comparison with the selected group,we find an average of 51.5 which is

[1]Ibidem. p.54.

also much lower than the 78.6 of the selected group.The range is 18 more in the Group C,but conforms closely to Group A,and Group B. The reliability of the measure of deviation is nearly the same as the selected group,being 4.9 as compared to 4.76, expressed in terms of the standard error.The measures of this group are more reliable than for Group A,with a S.E.(standard error) of 5.6,and for Group B,with a S.E. of 5.8. In comparing three unselected groups to the one selected group,we find almost uniform results,showing that one unselected group is all that would ordinarily be needed for comparison to secure a good reliability. We have used three groups because they were tested separately in the first place,and also because a team of scores is more reliable than a brger number pooled into one group. Our conclusions already cited above seem to be verified threefold.

2.We have another selected group,shown in Table V,to compare with groups A,B,and C. This group is composed of advanced pianists studying at the Matthay Pianoforte School in London,England. Many have already given concerts,several have won scholarships,and others prizes.This group represents a better selection of musical talent,as shown by the degree of success and recognition already won, than the other selected group we have considered.The average for this group is 73 which is appreciably higher than the averages of 45, 59.5 and 51.5 for groups A,B,and C respectively.The range is 76 as compared to 93,77,and 95 for the other three groups respectively.The S.D. of 18.7 is much lower than 27.5,26,

and 28.7 for the other three groups. There is only one case where the score is below the average for Group A;there are four cases below the average for Group B;and there are three cases where the scores are below the average for Group C. The S.E.for this group is four,which is lower than for any group yet considered. A comparison of two selected groups with three unselected groups shows that in every instance the former secures a much higher score than the latter.This means that in general there is a fundamental difference between the musical and the unmusical and that this test is capable of measuring it. It is quite likely that in the unselected group there existed some who were talented,as some had studied as long as seven years and indicated that they enjoyed music. If such cases had been excluded from this group,our difference would in all probability have been greater still.Analysing the scores in the unselected groups,we find only five cases,in Group A,above the average of 73 in the Matthay School group,which was the lower average of the two selected groups.In Group B there are 8 cases above the average,and in Group C there are 11 cases above the average of the Matthay School group.Table VI shows the percentage of cases for each group whose scores were above the average of 73 in the Matthay School group.

.Correlation of score with musical education. Table VII shows the calculation of the coefficient of correlation of the score received in the pitch test and the number of years that the subject has studied music.This correlation of.539 shows a

fair correspondance, and should be interpreted as indicating that those who were musical continued studying music, and those who were not naturally musical, tended to discontinue studying music. For our purpose then, it shows that even in the unselected group we have a fair amount of talent, and by excluding this from the unselected group, our difference between the two would have been greater.

3. Conclusions. The difference that this test registers for selected and unselected groups of musical talent, is large enough, and consistent enough, to be termed significant as a measure of talent. It is quite capable of separating musical and non-musical groups in a large majority of cases, but would not be a safe criterion if this were the only means of testing.

TABLE 1

Table giving the calculation of the average, standard deviation, and probable or standard error, for pitch discrimination of students at the New England Conservatory of Music.

S	F	SxF	D	FD	FD^2
100	1	100	21.4	21.4	457.96
98	2	196	19.4	38.8	752.72
96	1	96	17.4	17.4	302.76
94	1	94	15.4	15.4	237.16
91	1	91	12.4	12.4	153.76
81	3	243	2.4	7.2	17.28
76	1	76	- 2.6	- 2.6	6.76
63	2	126	-15.6	-31.2	486.72
56	2	112	-22.6	-45.2	1021.52
45	1	45	-33.6	-33.6	1128.96
	15	1179			4565.60

Number = 15 Range = 55

Average= 78.6

$$\sigma = \sqrt{\frac{\Sigma FD^2}{N}} \quad (1) = \sqrt{\frac{4565.6}{15}} = \sqrt{304.7} = 17.455$$

$$\sigma_{av.} \text{ (standard error)} \quad (2) = \frac{\sigma_{dis.}}{\sqrt{N}} = \frac{17.455}{\sqrt{15}} = \frac{17.455}{3.87} = 4.76$$

TABLE 11

Calculation of the average, standard deviation, and standard error, of Group A composed of college students.

S	F	SxF	D	FD	FD^2
94	1	94	49	49	2401
91	1	94	46	46	2116
87	2	174	42	84	3528
76	1	76	31	31	961
63	1	63	18	18	324
56	3	168	11	33	363
50	3	150	5	15	75
45	1	45	0	0	0
40	1	40	- 5	- 5	25
32	1	32	-13	-13	169
29	1	29	-16	-16	256
23	3	69	-22	-66	1452
15	1	15	-30	-30	900
13	1	13	-32	-32	1024
12	1	12	-33	-33	1089
5	1	5	-40	-40	1600
1	1	1	-44	-44	1936
	24	1080			18219

Number = 24 Range = 93

Average= 45

$$\sigma = \sqrt{\frac{18219}{24}} = \sqrt{759.1} = 27.55$$

$$\sigma_{av.} = \frac{27.55}{\sqrt{24}} = \frac{27.55}{4.9} = 5.6$$

(1) For formula see, "Statistics in Psy. and Ed.", p. 27, Garrett.
(2) Ibidem, p. 121, formula 13.

TABLE III

Calculation of average, standard deviation, and standard error for pitch discrimination of Group B, college students.

S	F	SxF	D	FD	FD^2
94	1	94	34.5	34.5	1190.25
91	3	273	31.5	94.5	2976.75
87	2	174	27.5	55.0	1512.5
81	2	162	21.5	43.0	924.5
63	2	126	3.5	7.0	24.5
56	1	56	- 3.5	- 3.5	12.25
50	2	100	- 9.5	-19.0	180.5
45	1	45	-14.5	-14.5	210.25
36	1	36	-23.5	-23.5	552.25
32	1	32	-27.5	-27.5	756.25
29	1	29	-30.5	-30.5	930.25
26	1	26	-33.5	-33.5	1122.25
21	1	21	-38.5	-38.5	1482.25
17	1	17	-42.5	-42.5	1806.25
	20	1191			13681.00

Average = 59.5
Number = 20
Range = 77

$$\sigma = \sqrt{\frac{13681}{20}} = \sqrt{684.05} = 26$$

$$\sigma_{av.} = \frac{26}{\sqrt{20}} = \frac{26}{4.47} = 5.8$$

TABLE IV

Calculation of average, standard deviation, and standard error for pitch discrimination of Group C, college students.

S	F	SxF	D	FD	FD^2
96	1	96	44.5	44.5	1980.25
94	1	94	42.5	42.5	1806.25
91	1	91	39.5	39.5	1560.25
87	4	348	35.5	142.0	5041.00
81	2	162	29.5	59.0	1740.5
76	2	152	24.55	49.0	1200.5
70	2	140	18.5	37.0	684.5
56	2	112	4.5	9.0	40.5
50	2	100	- 1.5	- 3.0	4.5
45	3	135	- 6.5	- 19.5	127.75
40	2	80	-11.5	- 23.0	264.5
36	3	108	-15.5	- 46.5	720.75
29	1	29	-22.5	- 22.5	506.25
26	2	52	-25.5	- 51.0	1300.5
23	1	23	-28.5	- 28.5	812.25
13	2	26	-38.5	- 77.0	2964.5
4	1	4	-47.5	- 47.5	2256.25
1	2	2	-50.5	-101.0	5100.5
	34	1754			28111.50

Average = 51.5
Number = 34
Range = 95

$$\sigma = \sqrt{\frac{28111.5}{34}} = \sqrt{826.8} = 28.75$$

$$\sigma_{av.} = \frac{28.75}{\sqrt{34}} = \frac{28.75}{5.83} = 4.9$$

TABLE V

Calculation of average, standard deviation, standard error for pitch discrimination of the Matthay Pianoforte School group of artists.

S	F	SxF	D	FD	FD^2
99	2	198	26	52	1352
94	1	94	21	21	441
91	2	182	18	36	648
87	1	87	14	14	196
81	3	243	8	24	192
76	1	76	3	3	9
70	6	420	- 3	- 18	54
63	1	63	-10	- 10	100
56	1	56	-17	- 17	289
45	2	90	-28	- 56	1568
23	1	23	-50	- 50	2500
	21	1532			7349

Average = 73
Number = 21
Range = 76

$$\sigma = \sqrt{\frac{7349}{21}} = \sqrt{349.9} = 18.71$$

$$\sigma_{av.} = \frac{18.71}{\sqrt{21}} = \frac{18.71}{4.58} = 4$$

TABLE VI

Percentages of the cases by groups, where the scores are above the average of 73 found in the Matthay School group, in the test of pitch discrimination.

Group A	Group B	Group C	Matthay School	N.E.Conservatory
20%	40%	33%	50%	66%

TABLE V11

Calculation of the coefficient of correlation between score in pitch discrimination test and number of years musical education[1].

Subj.	S_1	S_2	D_x	D_y	$(D_x)^2$	$(D_y)^2$	+ xy	-xy
1	91	6	44.4	3.3	1971.36	10.89	146.52	
2	87	0	40.4	-2.7	1632.16	7.29		109.08
3	87	4	40.4	1.3	1632.16	1.69	52.52	
4	76	7	29.4	4.3	864.36	18.49	126.42	
5	63	7	16.4	4.3	268.96	18.49	70.52	
6	56	0	9.4	-2.7	88.36	7.29		25.38
7	56	5	9.4	2.3	88.36	5.29	21.62	
8	50	5	3.4	2.3	11.56	5.29	7.82	
9	50	4	3.4	1.3	11.56	1.69	4.42	
10	50	1	3.4	-1.7	11.56	2.89		5.78
11	45	3	- 1.6	.3	2.56	.9		4.8
12	40	1	- 6.6	-1.7	43.56	2.89	11.02	
13	32	1	-14.6	-1.7	213.16	2.89	24.82	
14	29	1	-17.6	-1.7	309.76	2.89	29.92	
15	23	4	-23.6	1.3	556.96	1.69		30.68
16	23	0	-23.6	-2.7	556.96	7.29	63.72	
17	12	1	-34.6	-1.7	1197.16	2.89	58.82	
18	5	0	-41.6	-2,7	1730.56	7.29	112.32	
19	1	1	-45.6	-1.7	2079.36	2.89	77.52	
					13270.44	110.92	806.98	-155.72
							-155.72	
							651.26	

$$r = \frac{651.26}{\sqrt{13270.44} \times \sqrt{110.92}} = \frac{651.26}{115.2 \times 10.52} = \frac{651.26}{1211.9} = .539$$

$$PE_r = \frac{.6745(1-(.539)^2}{\sqrt{19}} = \frac{.6745(1-.290521)}{4.36} = \frac{.6745(.7095)}{4.36} =$$

$$\frac{.478557}{4.36} \quad .109 \text{ (less than one third of r).}$$

[1]For formula see,"Statistics in Psychology and Education", H.E.Garrett, p.169.

PITCH

1.Results from pure guess. The method of securing these results was as follows: after the actual tests had been completed,the subjects were given another blank form and were instructed to fill in the spaces with L or S (the same symbols as were used in the actual test). They took these blanks home and filled them in during the week, so there was no possibility of any remembering the order they used during the test. TABLE XXXlll shows the results for Group B with twenty-two cases.The average is 50.8 with a standard error of .63 which indicates that even with so small a number, the reliability is very high. Assuming that the test was of the same difficulty throughout,and that the subject guessed at the answers which he was not sure of(the same as the directions given in the test),he would not change his final score, for he would guess as many wrong as right.As a score of 55 gives a ranking of only 3,and below 55 there is no method of ranking,in this test,the net result of guessing will be to make the rank score dependent entirely upon the answers given upon the basis of a real judgment.

2.Influence of most difficult column. In column F,sometimes called row in this report,the difference between the standard tuning fork and the increment fork is so small that the vast majority of subjects are forced to guess.Inasmuch as there are ten trials for this one interval,and the other columns are

comparatively easy, the results of this column would largely determine the ranking score. So it would seem from first inspection that chance would affect the raw score, and even more so the rank score. This does not appear to be the case however, at least not to the extent that it was first thought. On page 9 of the Manual of Instructions and Interpretations it will be seen that any raw score above 93 gives a ranking score of 100 and that this amply allows for the factor of chance in column F, for from TABLE XXXll we find the average number of mistakes for this row to be 4.56, and in no case out of the twenty did the number of mistakes exceed seven. As a matter of fact the returns from the chance answers for column F showed that there were fewer mistakes than for the highly selected Matthay School group where the average number of mistakes were 5.45 for column F. TABLE XXXlV also shows that in one case there were 9 mistakes, and that the answers are not as good as pure chance produced. Column G is the next most difficult column of trials and TABLE XXXll shows that in the chance answers there was an average of 4.9 mistakes, while actual answers for the same column were 3.55 for Group B, 3.6 for New England Conservatory group (TABLE XXXV), and 4.2 for the Matthay School group (TABLE XXXlV). Only columns F and G are considered in this more direct way because from TABLES XXXll and XXXlV, the total average percentage of mistakes is found to be much greater than in any of the other columns. This is also shown in TABLES XXXlV and XXXV where the actual average mistakes are shown for all columns and confirms quite clearly that the factor of chance

enters very little into the other columns of trials.In TABLE XXXll,column E did not get recorded because the phonograph began to run down and it was stopped.TABLE XXXlV is therefore given to show what error this omission may have caused,and out of 33 cases this omission amounts to three percent of the total errors,which would not alter our calculations for columns F and G. It will be noticed that in TABLE XXXll eighty percent of the total mistakes were contributed by the four columns F,G,H,and I,and that for TABLE XXXlV eighty-six percent of the mistakes were contributed by the same columns.The same tables also show that the other columns were sufficiently easy for most subjects to get them all right,except in exceptional instances.If proper allowance could be made for attenuation,it seems likely that the mistakes occuring in columns other than F,G,H,or I,are mostly due to lack of concentration or other disturbing factors.This would mean that all the answers in these other columns are the result of a judgment,and only in the four columns mentioned would there be guesses,and this seems to be allowed for in the system of ranking.

3.Conclusions. The influence of chance is not great enough to injure the validity of this test to any extent. In a few indiviaual cases the rank score could be effected but in general,the results are as good as can be secured by psycho-physical methods.

TABLE XXXII

	Rank score	Actual score	Score by chance	Percentages of errors by rows from actual test										Percentages of errors by rows from chance trial										Chance errors by rows				Actual errors by rows			
				A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	F	G	H	I	F	G	H	I
Brown	26	76	48	0	.04	0	.02		.18	.09	.09	.13	.13	.04	.11	.08	.13	.08	.11	.13	.11	.08	.09	67	64			42	26		
Blacklow	50	81	55	0	0	0	.12		.35	.17	.17	.17	0	.06	.09	.15	.11	.06	.09	.11	.13	.09	.09	45	64			63	33		
Couser	87	87	51	0	.08	.17	.25		.17	.08	.08	.08	.08	.14	.10	.06	.08	.10	.14	.08	.08	.06	.14	74	45			21	11		
Carey	81	86	51	0	0	0	0		.38	.31	.08	.24	0	.06	.18	.09	.11	.11	.04	.11	.02	.13	.13	25	16			04	13		
Dudley	17	71	46	0	0	0	0		.38	.31	.19	.12	0	.11	.09	.15	.13	.07	.11	.09	.05	.09	.11	05	35			05	32		
Daloz	94	89	50	0	0	0	.27		.27	.18	.09	.18	0	.07	.07	.13	.07	.15	.07	.11	.09	.11	.09	46	56			32	12		
Fraser	50	81	52	0	0	0	.06		.12	.29	.29	.12	.12	.14	.04	.12	.12	.10	.12	.08	.10	.08	.06	64	54			55	22		
Googins	21	73	49	0	0	.04	.17		.13	.33	.17	.12	.04	.13	.08	.12	.08	.16	.04	.06	.16	.08	.12	23	84			38	43		
Geter	81	86	56	0	0	0	.08		.38	.38	.08	.08	0	.15	.09	.04	.11	111	.09	.04	.11	.11	.11	42	55			55	11		
Glover	91	88	54	0	0	0	0		.36	.45	.09	.09	0	.08	.15	.06	.08	.08	.08	.11	.15	.13	.04	45	76			45	11		
Goodwin	63	83	47	0	0	0	.07		.27	.20	.20	.13	.13	.05	.13	.05	.13	.09	.11	.11	.07	.09	.13	66	45			43	32		
Googins	56	82	50	0	0	0	.06		.25	.19	.19	.19	.12	.12	.18	.10	.06	.12	.12	.06	.06	.06	.12	63	33			43	33		
Hamilton	87	87	57	0	0	0	.08		.17	.17	.17	.33	.08	.04	.09	.11	.11	.07	.09	.11	.11	.14	.09	45	56			32	24		
McGowan	63	83	49	0	0	0	.20		.33	.13	.27	.07	0	.08	.14	.10	.14	.12	.08	.08	.06	.10	.12	44	35			52	41		
McGuane	91	88	50	0	0	0	.27		.27	.27	.18	.0	0	.04	.08	.14	.12	.14	.06	.10	.10	.14	.08	35	57			33	20		
Malchman	36	78	51	0	0	0	.20		.35	.20	.15	.10	0	.12	.08	.08	.14	.10	.08	.10	.08	.10	.10	45	45			74	32		
Sutherland	26	75	47	0	0	0	.09		.26	.13	.17	.17	.0	.15	.09	.17	.07	.07	.07	.11	.09	.09	.05	46	55			63	44		
Shapiro	45	80	55	0	0	0	0		.28	.33	.17	.22	.0	.06	.09	.13	.13	.06	.06	.11	.09	.15	.09	35	47			56	34		
Schelir	91	88	52	0	0	0	.27		.27	.09	.09	.27	0	.04	.12	.14	.14	.06	.08	.12	.06	.10	.10	46	35			31	13		
Swanson	32	77	48	0	0	0	.14		.14	.19	.24	.24	.05	.08	.09	.09	.13	.02	.13	.09	.11	.11	.11	75	66			34	55		
Average percent error by rows				.000	.006	.0105	.1325	.--	.265	.224	.158	.1525	.046	.087	.104	.104	.11	.036	.088	.095	.091	.102	.098								
Average of actual errors by rows																								.4400	.4000	.3000	.4600	.4200	.3200	.2000	.4400

TABLE XXXlll

Calculation of average, standard deviation, and standard error of Group B for forms filled in by chance for pitch test. (Raw-unranked-scores).

S	F	SxF	D	FD	FD^2
57	1	57	6.2	6.2	38.44
56	1	56	5.2	5.2	27.04
55	2	110	4.2	8.4	35.28
54	1	54	3.2	3.2	10.24
52	2	104	1.2	2.4	2.88
51	4	204	.2	.8	.16
50	3	150	.8	2.4	1.92
49	3	147	1.8	5.4	9.72
48	2	96	2.8	5.6	15.68
47	2	94	3.8	7.6	28.88
46	1	46	4.8	4.8	23.04
	22	1118			193.28

Average = 50.8

Number = 22

Range = 11

$$\sigma = \sqrt{\frac{193.28}{22}} = \sqrt{8.78} = 2.96$$

$$\sigma_{av.} = \frac{2.96}{\sqrt{22}} = \frac{2.96}{4.69} = .63$$

TABLE XXXlV

Percentages of mistakes by rows in Group C; actual mistakes by rows in four most frequently occuring. Given to show amount of error likely in TABLE XXXll where row E was missing.

	Score	A	B	C	D	E	F	G	H	I	J	F	G	H	I
Abrams	81	0	0	.06	0	0	.26	.16	.26	.26	0	5	3	5	5
Brown	69	0	0	.06	.06	.06	.10	.22	.26	.13	.10	3	7	8	4
Beaton	82	0	0	0	0	0	.33	.22	.22	.17	.05	6	4	4	3
Bertocci	75	0	.04	.12	.12	.24	.16	.16	.12	.04	0	4	4	3	1
Bertram	76	0	0	.04	.0	.04	.25	.29	.25	.04	.08	6	7	6	1
Blunt	82	0	0	0	0	0	.39	.33	.11	.11	.05	7	8	2	2
Brown	79	0	0	0	0	0	.24	.28	.38	.0	.10	5	6	8	0
Brown H	45	.07	.09	.11	.11	.13	.11	.04	.13	.15	.07	6	2	7	8
Brown O	87	0	0	0	0	0	.46	.24	.15	.08	.08	6	3	2	1
Callahan	89	0	0	0	0	0	.36	.36	.10	.18	0	4	4	1	2
Cleary	87	0	0	0	0	0	.38	.24	.24	.15	.0	5	3	3	2
Claus	78	0	0	0	0	0	.27	.18	.27	.18	.09	6	4	6	4
Connors	87	0	0	0	0	.08	.31	.38	.08	.15	0	4	5	1	2
Dani	86	0	0	0	0	0	.29	.29	.36	.07	.0	4	4	5	1
Diskei	89	0	0	0	0	0	.27	.45	.0	.27	0	3	5	0	3
Fisher	85	0	0	0	0	.07	.20	.33	.33	.07	0	3	5	0	1
Gavin	84	.06	0	0	0	0	.19	.44	.25	.06	0	3	7	4	1
Grodberg	58	.06	.03	.22	.24	.19	.09	.09	.0	.09	0	5	3	0	3
Healey	69	0	.06	.10	.03	.10	.16	.06	.23	.06	.19	5	2	7	2
Hoberman	76	0	0	0	0	0	.27	.13	.41	.13	.04	6	3	9	3
Hogan	90	0	0	0	0	0	.20	.40	.10	.30	0	2	4	1	3
Lafleur	79	0	0	0	0	0	.24	.33	.24	.09	0	3	7	7	2
Litchman	80	0	0	0	0	0	.25	.20	.30	.20	.05	5	4	6	4
Lockwood	86	0	0	0	0	0	.36	.29	.07	.21	.07	5	4	1	3
Manuel	81	.10	0	0	0	0	.21	.37	.10	.10	.10	4	7	2	2
Miller	87	0	0	0	0	0	.46	.24	.08	.15	.08	6	3	1	2
Muller	75	0	.04	0	.04	0	.20	.12	.16	.24	.20	5	3	4	6
Patridge	84	0	0	0	0	0	.38	.38	.12	.06	.06	6	6	2	1
Schluse	85	0	0	0	0	0	.20	.40	.27	.07	.07	6	4	3	1
Senders	80	0	0	0	0	0	.30	.30	.15	.20	.05	6	6	4	3
Shuman	88	0	0	0	0	.17	.08	.33	.08	.25	.08	1	4	1	3
Stevenson	78	0	0	0	0	0	.27	.41	.18	.13	.00	6	9	4	3
Yinger	80	0	.00	0	0	.05	.25	.20	.30	.15	.05	5	4	6	3

Total percent of errors by rows

A	B	C	D	E	F	G	H	I	J
.009	.008	.02	.016	.034	.227	.268	.19	.175	.05

Av. mistakes by rows

F	G	H	I
4.7	4.6	3.8	2.6

TABLE XXXV

Number and average of mistakes by rows for New England Conservatory group in the pitch test.

Subject	A	B	C	D	E	F	G	H	I	J	Av. mistakes by rows
1	0	0	0	0	0	1	1	2	2	0	
2	0	0	0	0	0	3	3	2	1	0	
3	0	0	0	0	0	4	2	2	1	0	
4	0	0	0	0	0	4	3	2	1	0	
5	0	0	0	0	0	4	1	3	3	0	
6	0	0	0	0	0	2	5	4	1	0	
7	0	0	0	0	0	2	6	3	5	3	
8	0	0	0	0	0	2	6	3	1	2	
9	0	0	0	0	0	6	1	4	1	0	
10	0	0	0	0	0	3	3	5	2	1	
11	0	0	0	0	0	6	7	4	0	0	
12	0	0	0	0	0	7	3	3	2	0	
13	0	0	0	0	0	5	6	4	3	0	
14	0	0	0	0	0	7	6	2	2	0	
15	0	0	0	0	0	7	4	5	3	1	
	0	0	0	0	0	4.3	3.6	3.000	1.866	.466	

TABLE XXXVI

Mistakes by rows for Matthay School group test of pitch

Subj.	A	B	C	D	E	F	G	H	I	J
1	0	0	0	0	3	5	4	2	2	0
2	0	0	0	0	0	3	5	3	1	0
3	0	0	0	0	0	6	4	5	6	5
4	0	0	0	0	0	9	6	2	1	2
5	0	0	0	0	0	5	5	2	0	0
6	0	0	0	0	0	5	4	4	2	1
7	0	0	0	0	0	6	3	1	1	0
8	0	0	0	0	0	3	5	5	3	1
9	0	0	0	2	0	3	5	4	0	0
10	0	0	0	0	0	4	2	1	1	0
11	0	0	0	0	0	7	4	3	2	0
12	0	0	0	0	0	6	5	3	2	0
13	0	0	0	0	0	6	5	3	1	0
14	0	0	0	0	0	6	7	1	1	1
15	0	0	0	0	0	6	3	5	2	0
16	0	0	0	0	1	5	3	2	1	1
17	0	0	0	0	0	6	6	3	1	0
18	0	0	0	0	0	7	1	5	1	0
19	0	0	0	0	0	5	1	1	1	0
20	0	0	0	0	0	6	6	4	1	1
	0	0	0	.1	.2	5.45	4.2	2.45	1.5	.6

Av. mistakes by rows

1.New England Conservatory group compared to college groups. The instructions given for this test were,"You will hear three clicks marking off two intervals of time.If the second interval (that is,the time between the second and third clicks) is longer than the first interval, record L;if it is shorter,record S."[1] In this selected group we find that the average is 61,and Group A is 14.5 lower,or 46.5.As these scores are not the raw scores,but are the rankings that each raw score represents in a normal community, this difference is even greater than it seems.The S.D. is rather high,being 24.27 for the first group,and 29.98 for the second. There is a negligable difference in the standard errors as they are 6.3 and 6.2 respectively.The range in the first group is 29 lower than in the second,and there are no scores lower than 28 in the first,while Group A has a score as low as 3.There are however two scores in Group A which exceed the highest score of 94 in the New England Conservatory group.

In Group B the average is 36.8 which is almost ten points lower than for Group A.The S.D.and S.E. for this group compared to the selected group are very nearly the same.The range for Group B is very large as it is 96.

For Group C the average is higher than in the other two unselected groups,but it is still ten points lower than for the selected group.The S.D.and S.E.are 29.7 and 5.3.For the selected group they are 24.27 and 6.3 respectively.The range for this group is even higher than in any of the other unselected groups,and reaches the maximum of 99 as the scores go from zero to one hundred

[1] C.E.Seashore,"Manual of Instructions and Interpretations",p.11. New York 1919.

which includes the lowest and the highest possible rankings.

2. Matthay School group compared to college groups. In this highly selected group we find a rather high average as compared to the other selected group, and all the unselected groups. We should expect such a result however if the sense of time is one of the fundamental factors of musical ability. The average is 74.2, and for Group A it is only 46.5. The S.D. is ten points less, and the S.E. is one point less and indicates that our measures have been more accurate for the last group. The range is 70 as compared to 95 in the other group, and there is only one score below the average for Group A. On the other hand there are two scores in Group A which exceed by 3 and 4 points respectively the highest scores for either of the selected groups. One of these scores was made by a sophomore who has studied piano for five years, enjoys classical music, his father is the leader of the Dallas Male Chorus, and his mother is a graduate of the New England Conservatory of Music and teaches piano. This subject is obviously musical, which may explain the high score that he received. The other score was made by a subject who indicates no musical education on the questionaire filled in by all subjects, his enjoyment of music is only moderate, and his parents show no musical inclination. Although he possesses a fine sense of time discrimination, he apparently lacks other factors which are necessary for the appreciation and understanding of music. This seems to be adequately measured by the low score of 15 made by him in the test of pitch.

In Group B the average is 36.8 which is practically half the average for the Matthay School group. TABLES X and XII show the S.D.'s and S.E.'s for each group . There is one score in the selected group which is lower than the average for the other, and there is one score in the unselected group which is higher than the highest in the other. This last score was made by a subject who has studied piano four years and violin two years, enjoys classical music, and whose mother plays piano and organ. This subject's score in the pitch discrimination test was also high, being 91.

Group C has a rather high average compared to the other unselected groups, yet it is only 51.6, while the Matthay School group averages 74.2. TABLES X and XIII give the S.D.'s and S.E.'s, the latter being practically the same, and the former are separated by ten points. In the two scores made by this selected group that are higher than the highest of the other group, we find that one was made by a subject who has not studied music but enjoys classical music. There is little musical ability in the family although an ancestor was an organist. The other score is the only one that has a ranking of 100 from any other of the groups. This subject has studied voice a little, and his father sings a little. His enjoyment of music is "very, very much", as indicated by the answer on the questionaire. His score in the pitch discrimination test is above the average of any other group either selected or unselected.

3.Conclusions. Although there is a tendency for this test to register a higher score for the musical groups it is not a strong enough tendency to have much importance. Out of six comparisons only three are significant,although the fourth comparison is nearly significant(see TABLE XXXVll). Our results show that there is a doubt about the value of this test. There is a large overlapping of musical subjects having a low score,and of unmusical subjects having a high score. From such results it seems dangerous to rely very strongly on this test,except as a supplement to other more fundamental tests.

TABLE IX

Calculation of average, standard deviation, standard error, for time discrimination of New England Conservatory group.

S	F	SxF	D	FD	FD^2
94	1	94	33	33	1089
90	3	270	29	87	2523
87	1	87	26	26	676
73	1	73	12	12	144
67	2	134	6	12	72
54	1	54	- 7	- 7	49
42	1	42	-19	-19	361
37	2	74	-24	-48	1152
32	2	64	-29	-58	1682
28	1	28	-33	-33	1089
	15	920			8837

Average = 61
Number = 15
Range = 66

$$\sigma = \sqrt{\frac{8837}{15}} = \sqrt{589} = 24.27$$

$$\sigma_{av.} = \frac{24.27}{\sqrt{15}} = \frac{24.27}{3.87} = 6.3$$

TABLE X

Calculation of average, standard deviation, and standard error for time discrimination of Matthay School group.

S	F	SxF	D	FD	FD^2
94	2	188	20	40	800
90	3	270	16	48	748
78	2	156	4	8	32
73	3	219	- 1	- 3	3
54	2	108	-20	-40	800
24	1	24	- 50	-50	2500
	13	965			4883

Average = 74.2
Number = 13
Range = 70

$$\sigma = \sqrt{\frac{4883}{13}} = \sqrt{375} = 19.4$$

$$\sigma_{av.} = \frac{19.4}{\sqrt{13}} = \frac{19.4}{3.6} = 5.2$$

TABLE XI

Calculation of average, standard deviation, and standard error for time discrimination of Group A, college students.

S	F	SxF	D	FD	FD^2
98	1	98	51.5	51.5	2622.25
97	1	97	50.5	50.5	2550.25
87	1	87	40.5	40.5	1640.25
78	2	156	31.5	63.0	1984.5
73	2	146	26.5	53.0	1404.5
67	1	67	20.5	20.5	420.25
54	3	162	7.5	22.5	168.72
48	1	48	1.5	1.5	2.25
37	2	74	- 9.5	-19.0	180.5
28	2	56	-18.5	-37.0	684.5
20	3	60	-26.5	-79.5	2106.75
9	1	9	-37.5	-37.5	1406.25
5	1	5	-41.5	-41.5	1722.25
3	2	6	-43.5	-87.0	3784.5
	23	1071			20677.72

Average = 46.5
Number = 23
Range = 95

$$\sigma = \sqrt{\frac{20677.72}{23}} = \sqrt{899} = 29.98$$

$$\sigma_{av.} = \frac{29.98}{\sqrt{23}} = \frac{29.98}{4.8} = 6.2$$

TABLE XII

Calculation of average, standard deviation, and standard error for time discrimination of Group B, college students.

S	F	SxF	D	FD	FD^2
97	1	97	60	60	3600
73	2	146	36	72	2592
61	3	183	24	72	1728
54	1	54	17	17	289
48	1	48	11	11	121
42	1	42	5	5	25
37	1	37	0	0	0
32	3	96	5	15	75
16	1	16	21	21	441
13	1	13	24	24	576
11	2	22	26	52	1352
9	1	9	28	28	784
7	1	7	30	30	900
3	1	3	34	34	1156
1	1	1	36	36	1296
	21	774			14935

Average = 36.8 (37)
Number = 21
Range = 96

$$\sigma = \sqrt{\frac{14935}{21}} = \sqrt{711} = 26.6$$

$$\sigma_{av} = \frac{26.6}{\sqrt{21}} = \frac{26.6}{4.58} = 5.8$$

TABLE XIII

Calculation of average, standard deviation, and standard error for time discrimination of Group C, college students.

S	F	SxF	D	FD	FD^2
100	1	100	48.4	48.4	2342.56
97	1	97	45.4	45.4	2061.16
94	2	188	42.4	84.8	3575.32
90	1	90	38.4	38.4	1474.56
87	2	174	35.4	70.8	2506.32
83	1	83	31.4	31.4	985.96
78	1	78	26.4	26.4	696.96
73	1	73	21.4	21.4	457.96
54	5	270	2.4	12.0	28.8
48	3	144	- 3.6	-10.8	38.88
37	3	111	-14.6	-43.8	639.48
32	1	32	-19.6	-19.6	384.16
28	1	28	-23.6	-23.6	556.96
24	2	48	-27.6	-55.2	1523.52
20	1	20	-31.6	-31.6	998.56
16	1	16	-35.6	-35.6	1267.36
11	2	22	-40.6	-81.2	3296.72
7	1	7	-44.6	-44.6	1989.16
1	1	1	-50.6	-50.6	2560.36
	31	1582			27384.76

Average = 51.6
Number = 31
Range = 99

$$\sigma = \sqrt{\frac{27384.76}{31}} = \sqrt{883.38} = 29.7$$

$$\sigma_{av.} = \frac{29.7}{\sqrt{31}} = \frac{29.7}{5.57} = 5.3$$

1.New England Conservatory group compared to college groups. The instructions given with this test were,"In each trial you will hear a series of tones played twice.In the second playing,one note is changed.You are to record,by number,which one was changed.In listening count mentally;for example,1,2,3, in the first playing, and then likewise in the second playing,so that you may identify the one that was changed without error."[1] In the selected group the average is 72,and for the other group,Group A,the average is 67.2.This small difference is not significant.The S.D. of the first group is 20.3,the latter is 21.6,and the S.E.'s for the same groups are 5.5 and 3.2 respectively.Because of the larger number of cases in the latter group the accuracy of the obtained average is higher.

In Group B the average is only 58.6,or almost ten points below the average for Group A,and compared to the average of 72 for the New England Conservatory group,the difference indicates that it is a real one for the two groups.There is no real difference between the S.E.'s for the two groups.

3.Matthay School group compared to college groups.The obtained average for the Matthay School group is 93.3,as calculated in TABLE XVl, and the S.E. for this average is only 1.5.This is considerably higher than the average for Group A which is 67.2. The S.D. of the selected group is only 5.9 as compared to 21.6,and the S.E. is 1.5 compared to 3.2.

Group B shows even a larger discrepancy when its average of 58.6 is compared to 93.3 of the highly selected group.TABLE XVlll and TABLE XVl show that the S.D. for Group B is 26.5 and only

[1]C.E.Seashore,"Manual of Instructions and Interpretations".

5.9 for the Matthay School group of pianists.For the latter group the standard error is 1.5 and for Group B it is 5.

3.Royal Academy of Music group compared to college groups. For this test of tonal memory we have a third selected group taken from a first year class in aural training at the Royal Academy of Music in London.This group represents students from eighteen to twenty years of age who are studying either voice, violin,or piano. This group is practically no better in this test than the unselected groups, as Group A has an average of 67.2 and this group is 67.8. TABLES XVll and XlX show that the standard deviations are nearly the same,and that the standard error is small for Group A.

Group B has a smaller average than this selected group, yet the difference is not great enough to be significant.The selected group has an average of 67.8 and the other group averages 58.6. TABLES XVlll and XlX show the standard errors and standard deviations.

4.Conclusions. Out of three selected groups,there is only one that shows any real difference,or superiority over the two unselected groups.This indicates that the capacity for tonal memory is not a fundament of musical talent,but is an advantageous ability to possess.In the highly selected group of pianists at the Matthay School,

most of whom are young artists,we find that out of sixteen cases there is no score below 83. This superiority may be due to training,and this seems a likely explanation, or it may be that superiority in this capacity was a large contributing factor to the success of this group.There are other factors that may explain the high score of this selected group,such as the effects of melodic relationship, in which,"it is impossible, objectively, to change a single tone of a melody without changing the psychological status of its adjoining tones, and,to a less degree, that of all other tones of the melody falling withing the memory-span".[1] A trained musician who is able to analyze,and name each interval, might experience less difficulty in determining which tone,in a second series,had been changed,as called for in this test. This advantage is hardly adequate however to account for the difference observed.Inasmuch as two selected groups show no significant superiority over our two unselected groups,the explanation seems that already given above,i.e. tonal memory is not a fundament of musical talent,but is an advantageous ability to possess.This does not conflict with the conclusion of Otto Ortmann who found, "melodic memory is one element of musical talent,and may be sufficiently isolated to permit separate grading" [2],as it is no doubt an element,but differing but little from memory in general.Needless to say that for the concert artist it is indespensable.This test seems useful,but is not measuring a fundamental capacity of music in general, as proposed by its author.

[1]Otto Ortmann,"On the Melodic Relativity of Tones", Psychol.Monog.Vol.XXXV,1,1926. No.162. p.34.
[2]Ibidem,p.146.

TABLE XV

Calculation of average, standard deviation, and standard error of New England Conservatory group for tonal memory test.

S	F	SxF	D	FD	FD^2
100	1	100	28	28	784
99	1	99	27	27	729
95	1	95	23	23	529
83	2	166	11	22	242
79	1	79	7	7	49
75	1	75	3	3	9
65	3	195	- 7	-21	147
60	1	60	-12	-12	144
41	1	41	-31	-31	961
30	1	30	-42	-42	1764
	13	940			5358

Average = 72
Number = 13
Range = 70

$$\sigma = \sqrt{\frac{5358}{13}} = \sqrt{412} = 20.3$$

$$\sigma_{av.} = \frac{20.3}{\sqrt{13}} = \frac{20.3}{3.6} = 5.5$$

TABLE XVI

Calculation of average, standard deviation, and standard error of Matthay School group for tonal memory test.

S	F	SxF	D	FD	FD^2
100	2	200	7	14	98
99	2	198	6	12	72
98	1	98	5	5	25
97	2	194	4	8	32
95	3	285	2	6	12
93	1	93	0	0	0
91	1	91	- 2	- 2	4
89	1	89	- 4	- 4	16
83	3	249	-10	-30	300
	16	1497			559

Average =93.3
Number =16
Range =17

$$\sigma = \sqrt{\frac{559}{16}} = \sqrt{35} = 5.9$$

$$\sigma_{av.} = \frac{5.9}{\sqrt{16}} = \frac{5.9}{4} = 1.5$$

TABLE XVII

Calculation of average, standard deviation, standard error of Group A for tonal memory test.

S	F	SxF	D	FD	FD^2
97	2	194	30	60	1800
95	1	95	28	28	784
91	3	273	24	72	1728
87	6	522	20	120	2400
85	1	85	18	18	324
83	4	332	16	64	1024
79	2	158	12	24	288
75	4	300	8	32	256
71	2	142	4	8	32
65	2	130	- 2	- 4	8
60	3	180	- 7	-21	147
57	1	57	-10	-10	100
55	3	165	-12	-36	432
50	1	50	-17	-17	289
45	5	225	-22	-110	2420
37	2	57	-30	-30	900
30	2	60	-37	-74	2738
13	1	13	-44	-44	1936
9	1	9	-58	-58	3364
	43	3017			25779

Average = 67.2
Number = 45
Range = 88

$$\sigma = \sqrt{\frac{20970}{45}} = \sqrt{466} = 21.6$$

$$\sigma_{av.} = \frac{21.6}{\sqrt{45}} = \frac{21.6}{6.71} = 3.2$$

TABLE XVlll

Calculation of average, standard deviation, and standard error of Group B, for tonal memory test.

S	F	SxF	D	FD	FD^2
99	1	99	40.5	40.5	1640.25
97	1	97	38.5	38.5	1482.25
95	1	95	36.5	36.5	1332.25
91	11	91	32.5	32.5	1056.25
87	3	261	28.5	85.5	2436.75
83	1	83	24.5	24.5	600.25
76	3	225	16.5	49.5	816.75
71	1	71	12.5	12.5	156.25
65	2	130	6.5	13.0	84.5
55	1	55	- 3.5	- 3.5	12.25
50	1	50	- 8.5	- 8.5	72.25
45	4	180	-13.5	-54.0	739.0
37	1	37	-21.5	-21.5	462.25
34	1	34	-24.5	-24.5	600.25
30	1	30	-28.5	-28.5	812.25
27	1	27	-31.5	-31.5	992.25
23	2	46	-35.5	-71.0	2520.5
15	2	30	-43.5	-87.0	3784.5
	28	1641			19600.80

Average = 58.6
Number = 28
Range = 84

$$\sigma = \sqrt{\frac{19600.8}{28}} = \sqrt{700.2} = 26.5$$

$$\sigma_{av.} = \frac{26.5}{\sqrt{28}} = \frac{26.5}{5.3} = 5$$

TABLE XlX

Calculation of average, standard deviation, and standard error of Royal Academy of Music group, for tonal memory test.

S	F	SxF	D	FD	FD^2
100	1	100	32	32	1024
97	1	97	29	29	841
95	3	285	27	81	2187
91	2	182	23	46	1058
87	1	87	19	19	361
85	1	85	17	17	289
83	4	252	15	60	900
79	3	237	11	33	363
75	2	150	7	14	98
65	1	65	- 3	- 3	9
60	3	180	- 8	-24	192
50	1	50	-18	-18	324
41	3	123	-27	-81	2187
27	1	27	-41	-41	1681
23	2	46	-45	-90	4050
	29	1966			15564

Average = 67.8
Number = 29
Range = 77

$$\sigma = \sqrt{\frac{15564}{29}} = \sqrt{536.6} = 23.16$$

$$\sigma_{av.} = \frac{2316}{\sqrt{29}} = \frac{23.16}{5.38} = 4.3$$

1. New England Conservatory group compared to college groups. The instructions given were,"You will hear two tones which differ in loudness,or strength.You are to judge whether the second is weaker or stronger than the first.If the second is stronger,record S; if the second is weaker,record W".[1] This selected group has an average of 63 which is considerably higher than the 36 of Group A,as shown in TABLES XX and XXlll.The S.D.'s are 21.74 and 27.05 respectively,and the S.E.'s 5.7 and 4.1. The range is 88 for the first group and 95 for the second, and the differences between the two groups are significant as shown in TABLE XXXVll.

For Group B the average of 55 is not a great deal smaller than for the selected group and the S.D.'s of 5.7 and 5.3 respectively, make it not impossible for the averages to overlap,when larger groups of each are measured.TABLES XX and XXlV show the comparative scores,and from TABLE XXXVll it is seen that the difference is not at all significant.

2.Matthay School group compared to college groups. This group averages 74.9 and Group A only 36,and in view of the fact that this school represents a better selection of talent than any other,the difference appears to be one of musical ability,or possibly of training.TABLES XXl and XXlll show that the S.D.'s for each group is practically the same,while the S.E.for the first is higher than for Group A by five points.There is a slight difference in the ranges in favor of the selected group,the scores being 88 and 95.

[1]Seashore,"Manual of Instructions and Interpretations" p.10.

For Group B there is not so great a difference as noticed for Group A.The average is 55 ,standard deviation 27.53,and standard error 5.3,as shown in TABLES XXlV.

3.Royal Academy of Music group compared to college groups.For this selected group the average is 68.8 and for Group A it is only 36.TABLES XXll and XXlll show the standard deviations and standard errors and there is no remarkable difference.

In Group B the average is 55 and not a great deal smaller than for the selected group. In each the standard error is 5.3 which introduces a possibility of some overlapping of the two groups and lowers the reliability of the observed difference. TABLES XXll and XXlV show all comparisons .

4.Conclusions. In all of the three selected groups we find a superiority over the two unselected groups. In the first of the latter groups the difference is very marked,but this average seems to be below the normal average for the group that the test was standardized on.According to the manual of directions for the tests, the average of the ranked scores is about 50.The average for Group B then,is likely to be more nearly representative of unselected talent than is Group A's average.Although the difference does not appear great,it seems fairly constant as seen from a comparison of the selected groups. Here the Matthay School group is undoubtedly superior to the two other groups,and

We find that this is also indicated by the results of this test. Likewise it is shown by comparing the New England Conservatory group with the Royal Academy of Music group, where the latter probably represents a better selection of talent. The difference between the groups is hardly large enough to be termed significant as can be seen from TABLE XXVII. Such difference as there is however, may be of some value to musical expression, as from the research of Seashore and Tan[1] it is not likely to be the result of training. As a test it does not adaquately measure a fundamental capacity of musical talent.

[1] Seashore and Tan, "The Elemental Character of Sensory Discrimination:, Jour. of Ed. Psychol. 1916, 7.

TABLE XX

Calculation of average, standard deviation, and standard error of New England Conservatory of Music group, for sense of intensity test.

S	F	SxF	D	FD	FD^2
100	1	100	37	37	1369
95	1	95	32	32	1024
82	2	164	19	38	722
74	2	148	13	26	338
66	1	66	3	3	9
51	4	204	-12	-48	576
45	1	45	-18	-18	324
39	1	39	-24	-24	576
22	1	22	-41	-41	1681
	14	883			6619

Average =63
Number =14
Range =88

$$\sigma = \sqrt{\frac{6619}{14}} = \sqrt{472.77} = 21.74$$

$$\sigma_{av.} = \frac{21.74}{\sqrt{14}} = \frac{21.74}{3.74} = 5.7$$

TABLE XXl

Calculation of average, standard deviation, and standard error of Matthay School group, for sense of intensity test.

S	F	SxF	D	FD	FD^2
100	1	100	25	25	625
99	1	99	24	24	576
97	1	97	22	22	484
92	1	92	17	17	289
87	3	261	12	36	432
45	1	45	-30	-30	900
25	1	25	-50	-50	2500
22	1	22	-53	-53	2809
	10	749			8615

Average =74.9
Number =10
Range =88

$$\sigma = \sqrt{\frac{8615}{10}} = \sqrt{861.5} = 29.35$$

$$\sigma_{av.} = \frac{29.35}{\sqrt{10}} = \frac{29.35}{3.16} = 9.1$$

TABLE XXll

CALCULATION of average, standard deviation, and standard error of Royal Academy of Music group, forsense of intensity test. (Third year students).

S	F	SxF	D	FD	FD^2
97	1	97	28	28	784
95	1	95	26	26	676
92	2	184	23	46	1058
87	2	174	18	36	648
82	5	410	13	65	845
74	3	222	5	15	75
58	1	58	-11	-11	121
51	1	51	-18	-18	324
45	1	45	-24	-24	576
39	2	78	-30	-60	1800
22	1	22	-47	-47	2209
10	1	10	-59	-59	3481
	21	1446			12597

Average = 68.8
Number = 21
Range = 87

$$\sigma = \sqrt{\frac{12597}{21}} = \sqrt{599.8} = 24.48$$

$$\sigma_{av.} = \frac{24.48}{\sqrt{21}} = \frac{24.48}{4.58} = 5.3$$

TABLE XXlll

Calculation of average, standard deviation, and standard error of Group A, for sense of intensity test.

S	F	SxF	D	FD	FD^2
97	1	97	61	61	3721
92	1	92	56	56	3136
87	3	261	51	153	7803
66	3	198	30	90	2700
58	3	174	22	66	1452
51	1	51	15	15	225
45	2	90	9	18	162
39	4	156	3	12	36
29	2	58	- 7	-14	98
25	1	25	-11	-11	121
19	3	57	-17	-51	867
16	2	32	-20	-40	800
14	3	42	-22	-66	1452
12	2	24	-24	-48	1152
8	1	8	-28	-28	784
7	1	7	-29	-29	841
5	3	15	-31	-93	2883
2	2	4	-34	-68	2312
	42	1515			30753

Average = 36
Number = 42
Range = 95

$$\sigma = \sqrt{\frac{30753}{42}} = \sqrt{732.2} = 27.05$$

$$\sigma_{av.} = \frac{27.05}{\sqrt{42}} = \frac{27.05}{6.48} = 4.1$$

TABLE XXlV

Calculation of average, standard deviation, and standard error of Group B, for sense of intensity test.

S	F	SxF	D	FD	FD^2
99	1	99	44	44	1936
97	1	97	42	42	1764
95	2	190	40	80	3200
92	1	92	37	37	1369
87	1	87	32	32	1024
82	1	82	27	27	729
74	1	74	19	19	361
66	3	198	11	33	363
58	1	58	3	3	9
51	2	102	- 4	- 8	32
45	3	135	-10	-30	300
39	2	78	-16	-32	512
34	3	102	-21	-63	1323
29	2	58	-26	-52	1352
25	1	25	-30	-30	900
4	1	4	-51	-51	2601
3	1	3	-52	-52	2704
	27	1484			20479

Average =55
Number =27
Range =96

$$\sigma = \sqrt{\frac{20479}{27}} = \sqrt{758.5} = 27.53$$

$$\sigma_{av.} = \frac{27.53}{\sqrt{27}} = \frac{27.53}{5.2} = 5.3$$

1.New England Conservatory of Music group compared to college groups. The instructions given to each group were,"You will hear two combinations of two tones each;one combination is better or worse than the other in consonance(harmony).A good combination is one in which the two tones are smooth,and blend,tending to fuse together into one.A bad combination is just the opposite.If the second combination is better,record B;if worse,W.".[1] The average for this selected group is 66 and is seventeen points higher than the average of 49 for Group A. There is considerable difference in both the S.D.'s and ranges as seen from TABLES XXV and XXVlll which show a S.D. of 34.46 and a range of 96 for Group A,and 20.9 and 71 for the New England Conservatory group. The S.E. is 6.9 for the first group,and 5.4 for the latter,and the difference between the averages of the groups is not at all significant,as seen in TABLE XXXVll.

Group B has nearly as good an average as the selected group, being only seven points lower.It has a large range of 96 and TABLE XXlX shows that the S.D. and S.E. are both fairly high. The difference in the averages is not as significant even as the comparison of Group A.

Group C has an average of 55,range of 98,S.D. of 32,and S.E. of 5.5 as shown in TABLE XXX. In all three comparisons with the New England Conservatory group the differences have been quite unsignificant,and in Group B it was actually less than the observed difference(see TABLE XXXVll).

2.Matthay School group compared to college groups.This selected group is better than the one just considered,and has an average

[1]Seashore,"Manual of Instructions and Interpretations" p.12.

of 71. As there are only ten cases for this test, the S.E. exceeds that for Group A, it being 8.9 as compared to 6.9. TABLES XXVI and XXVIII show the other comparisons, and in the range there is particular superiority shown by the selected group, where it is 66 in one case and 96 in the other. There is no significant difference between the averages of the two groups.

Group B has about the same comparison as Group A, except that the difference is less significant (TABLE XXXVII).

Group C is shown in TABLE XXX and varies little from the other two unselected groups, with the exception that the S.E. is smaller. None of the college groups show a significant difference when compared with the Matthay School group, as can be seen in TABLE XXXVII.

3. Royal Academy of Music group compared to college groups. This group has a remarkably high average of 93.4 and is far greater than any of the unselected groups, and is the highest of the selected groups. In all other comparisons it is uniformly high. There is only one score below 86 and for this there is no satisfactory explanation.

The comparison of Group B with this selected group is shown in TABLE XXIX, and even though this is the highest of the unselected groups, it is still distinctly inferior to the Royal Academy group.

Group C is uniformly inferior, as were the other two unselected groups compared to the Royal Academy students, as seen from TABLES XXVII and XXX. In all comparisons the selected group has shown a significant difference with the unselected groups.

4.Conclusions. Out of nine comparisons,three are of value as showing a significant difference between the groups,and six show no significance at all. The three significant comparisons all occured with the Royal Academy of Music group as the average here is very high. The fact that there are more unsignificant comparisons than significant ones, indicates that this is not a good test. The singularly high average of the Royal Academy students seems to be adequatly explained by their special training in harmonic analysis where they became able to name all the intervals and to know which is the better interval when one is compared to another. It seems very obvious that what has been measured in this case is the result of training and not a "fundamental and essential capacity of the musical mind"[1]. Larson[2] and Heinlein[3] have shown serious faults in the method of ranking and the influence of adaptation has been pointed out by Diserens,[4] and shown experimentally by Meyer[5] and Valentine[6]. Seashore[7] has admitted the difficulty of making clear the meaning of consonance to all subjects,and especially to children.

[1] Seashore,"Manual of Instructions and Interpretations" p.1.

[2] "Critique of Seashore Consonance Test",Psychol.Monog. 1928,38,No.176 pp.63-68.

[3] "The Affective Character of the Major and Minor Modes in Music". J.Comp.Psychol., 1928,8, pp.101-147.

[4] THE INFLUENCE OF MUSIC ON BEHAVIOR, p.3. Princeton 1926.

[5] "Experimental Studies in the Psychology of Music",Am.J.Psychol., 1903,14,p.207.

[6] "The Method of Comparison with Musical Intervals and the Effect of Practice on the Appreciation of Discords", Brit.J.Psychol.,1914,7,pp.118-135.

[7] THE PSYCHOLOGY OF MUSICAL TALENT,p.154. Boston 1919.

TABLE XXV

Calculation of average, standard deviation, and standard error of New England Conservatory of Music group for the sense of consonance.

S	F	SxF	D	FD	FD^2
97	2	194	31	62	1922
78	5	390	12	60	720
68	3	204	2	6	12
56	1	56	-10	-10	100
46	1	46	-20	-20	400
36	2	72	-30	-60	1800
26	1	26	-40	-40	1600
	15	988			6554

Average =66
Number =15
Range =71

$$\sigma = \sqrt{\frac{6554}{15}} = \sqrt{437} = 20.9$$

$$\sigma_{av.} = \frac{20.9}{\sqrt{15}} = \frac{20.9}{3.87} = 5.4$$

TABLE XXVl

Calculation of average, standard deviation, and standard error of Matthay School group for the sense of consonance.

S	F	SxF	D	FD	FD^2
100	3	300	29	87	2523
99	1	99	28	28	784
93	1	93	22	22	484
56	2	112	-15	-30	450
36	2	72	-35	-70	2450
34	1	34	-37	-37	1369
	10	710			8060

Average =71
Number =10
Range =66

$$\sigma = \sqrt{\frac{8060}{10}} = \sqrt{806} = 28.39$$

$$\sigma_{av.} = \frac{28.39}{\sqrt{10}} = \frac{28.39}{3.16} = 8.9$$

TABLE XXVll

Calculation of average, standard deviation, and standard error of Royal Academy of Music group for the sense of consonance.

S	F	SxF	D	FD	FD^2
100	8	800	66	52.8	348.48
99	9	891	56	50.4	282.25
97	2	194	36	7.2	25.92
93	2	186	4	.8	.32
87	1	87	- 64	- 6.4	40.96
86	3	258	- 74	-22.2	164.28
12	1	12	-814	-81.4	6625.96
	26	2428			7488.17

Average=93.4
Number =26
Range =88

$$\sigma = \sqrt{\frac{7488.17}{26}} = \sqrt{288} = 16.97$$

$$\sigma_{av.} = \frac{16.97}{\sqrt{26}} = \frac{16.97}{5.099} = 3.3$$

TABLE XXVIII

Calculation of average, standard deviation, and standard error of Group A for sense of consonance.

S	F	SxF	D	FD	FD^2
100	1	100	51	51	2601
99	1	99	50	50	2500
97	2	194	48	96	4608
93	2	186	45	90	4050
86	1	37	37	37	1369
68	2	136	19	38	722
56	2	112	7	14	98
46	1	46	- 3	- 3	9
36	1	36	-13	- 13	169
26	5	130	-23	-115	2645
18	1	18	-31	- 31	961
12	1	12	-37	- 37	1369
8	1	8	-41	- 41	1681
6	2	12	-43	- 86	3698
4	1	4	-45	- 45	2025
	24	1179			28505

Average = 49
Number = 24
Range = 96

$$\sigma = \sqrt{\frac{28505}{24}} = \sqrt{1187.7} = 34.46$$

$$\sigma_{av.} = \frac{34.46}{\sqrt{24}} = \frac{34.46}{4.9} = 6.9$$

TABLE XXIX

Calculation of average, standard deviation, and standard error of Group B for sense of consonance.

S	F	SxF	D	FD	FD^2
97	1	97	38	38	1444
93	1	93	34	34	1156
86	3	258	27	81	2187
78	4	312	19	76	1444
68	5	340	9	45	405
46	1	46	-13	- 13	169
36	1	36	-23	- 23	529
26	1	33	-33	- 33	1089
8	2	16	-53	-106	5618
4	1	4	-55	- 55	3025
1	1	1	-58	- 58	3364
	21	1232			20372

Average = 59
Number = 21
Range = 96

$$\sigma = \sqrt{\frac{20372}{21}} = \sqrt{970} = 31.15$$

$$\sigma_{av.} = \frac{31.15}{\sqrt{21}} = \frac{31.15}{4.58} = 6.8$$

TABLE XXX

Calculation of average, standard deviation, and standard error of Group C for sense of consonance.

S	F	SxF	D	FD	FD^2
100	1	100	45	45	2025
99	1	99	44	44	1936
97	1	97	42	42	1764
93	2	186	38	76	2888
86	4	344	31	124	3844
78	4	312	23	92	2116
68	2	136	13	26	338
56	4	224	1	4	4
46	4	184	9	36	324
36	2	72	19	38	722
18	2	36	37	74	2738
8	2	16	47	94	4418
4	3	12	51	153	7803
2	1	2	53	53	2809
	33	1820			33729

Average = 55
Number = 33
Range = 98

$$\sigma = \sqrt{\frac{33729}{33}} = \sqrt{1022} = 32$$

$$\sigma_{av.} = \frac{32}{\sqrt{33}} = \frac{32}{5.74} = 5.5$$

1.Pitch discrimination

a.This test shows a reliability,significantly greater than chance,in selecting between musical and unmusical groups on the average.It has good diagnostic value.

b.It does not always show a close association with musical performance and is therefore not an indispensable criterion, and the test should not be the sole means used to discover musical talent. It is a good test to be used in a team of tests.

c.The factor of chance is not sufficiently disturbing to destroy the value of the results obtained.

2.Time discrimination

a.This test shows some evidence of association with musical talent,but the amount of association is not large enough to make it more than a supplementary test along with other better measuring instruments.

b.Although most of the subjects of the musical groups have good time discrimination,there are also a large number in the unmusical groups who obtain just as large a score.This large over-lapping makes it inaccurate as a test of musical ability.

3.Tonal memory

a.This test shows high correspondence with musical performance in particular cases where there is exceptional talent.

b.There is no evidence from this research that it is a reliable measuring instrument.In four comparisons out of six,with musical and unmusical groups,chance alone would

have given as large a difference. A large number in the unmusical groups got as large a score as the best in the musical groups.

c. It is important to note that where there is a difference, measured by this test, it is a very significant one, and conversely where it is not large it is considerably smaller than a chance relationship alone would give. This fact may be evidence that this test is measuring a fundament of musical talent which does not appear until the talent is of exceptional ability. This is not however proven in this research.

4. Intensity discrimination

a. There is a tendency for the musical groups to excel in this test but the difference is not large enough to be significant.

b. Half of the six comparisons are significant and the other half are not.

5. Consonance

a. Only three out of nine comparisons show any significant differences. They were all made by a group of musicians who had been especially trained in interval recognition.

b. Our results show that training is what is being most effectively measured in this test.

TABLE XXXI

Summary table of scores for all groups, for all tests.

	New England Conservatory average score	Standard error N.E.Conservatory	Matthay School average score	Standard error Matthay School	Royal Academy average score	Standard error Royal Academy	Group A average score	Standard error Group A	Group B average score	Standard error Group B	Group C average score	Standard error Group C
Pitch	78.6	4.3	75	4			49	5.6	59.6	5.8	51.5	4.9
Time	61	6.3	74	5.2			46.5	6.2	36.8	5.8	51.6	5.8
Conson-ance	66	5.4	71	8.9	93	5.3	49	6.9	59	6.2	55	5.5
Intens-ity	63	5.7	75	9.1	69	5.3	36	4.1	55	5.3		
Tonal memory	72	5.5	93	1.5	68	4.3	67	3.2	58.6	6		

TABLE XXXVII

Showing the significance of the difference in scores between compared groups. The observed difference is not considered significant unless it is three times the theoritical difference.(1)

Groups compared	Observed difference	$\sqrt{\sigma_{av.}{}^{a^2} + \sigma_{av.}{}^{b^2}}$	Theoritical difference	Relation to observed difference
PITCH				
New England C. Group A	29.6	$\sqrt{20+31} = \sqrt{51} =$	7.1	= 4
New England C. Group B	19	$\sqrt{20+33} = \sqrt{53} =$	7.2	= 2.6
New England C. Group C	27.1	$\sqrt{20+24} = \sqrt{44} =$	6.6	= 4
Matthay School Group A	25	$\sqrt{16+31} = \sqrt{47} =$	6.8	= 3.6
Matthay School Group B	13.4	$\sqrt{16+33} = \sqrt{49} =$	7	= 2
Matthay School Group C	21.5	$\sqrt{16+24} = \sqrt{40} =$	6.3	= 3.5
TIME				
New England C. Group A	14.5	$\sqrt{39.7+38} = \sqrt{77.7} =$	8.8	= 1.6
New England C. Group B	24.2	$\sqrt{39.7+33.6} = \sqrt{73.3} =$	8.5	= 2.8
New England C. Group C	9.4	$\sqrt{39.7+33.6} = \sqrt{73.3} =$	8.5	= 1.1
Matthay School Group A	25	$\sqrt{27+38} = \sqrt{65} =$	8	= 3
Matthay School Group B	37.2	$\sqrt{27+33.6} = \sqrt{60.6} =$	7.7	= 4.9
Matthay School Group C	22.4	$\sqrt{27+33.6} = \sqrt{60.6} =$	7.7	= 3
CONSONANCE				
New England C. Group A	17	$\sqrt{29+47.6} = \sqrt{76.6} =$	8.7	= 1.9
New England C. Group B	7	$\sqrt{29+38} = \sqrt{67} =$	8.1	= 1.1 larger than observed diff.
New England C. Group C	11	$\sqrt{29+30} = \sqrt{59} =$	7.6	= 1,4
Royal Academy Group A	44	$\sqrt{10.8+47.6} = \sqrt{58.4} =$	7.6	= 4
Royal Academy Group B	34	$\sqrt{10.8+38} = \sqrt{48.8} =$	7	= 5
Royal Academy Group C	38	$\sqrt{10.8+30} = \sqrt{40.8}$	6	= 6.3

TABLE XXXVII

(continued from preceeding page)

Groups compared	Observed difference	$\sqrt{\sigma_{av.}{}^{a^2} + \sigma_{av.}{}^{b^2}}$	Theoritical difference	Relation to observed difference
CONSONANCE(continued)				
Matthay School Group A	22	$\sqrt{79-47.6} = \sqrt{126.6} =$	11.2 =	2
Matthay School Group B	12	$\sqrt{79-38} = \sqrt{117} =$	10.8 =	1.1
Matthay School Group C	16	$\sqrt{79-30} = \sqrt{109} =$	10.4 =	1.5
INTENSITY				
New England C. Group A	27	$\sqrt{32.5-16=8} = \sqrt{49.3} =$	7 =	4
New England Co Group B	8	$\sqrt{32.5-28} = \sqrt{60.5} =$	7.7 =	1.1
Matthay School Group A	39	$\sqrt{82.8-16.8} = \sqrt{99.6} =$	10 =	4
Matthay School Group B	20	$\sqrt{82.8-28} = \sqrt{110.8} =$	10.5 =	1.9
Royal Academy Group A	33	$\sqrt{28-16.8} = \sqrt{44.8} =$	6.7 =	4.9
Royal Academy Group B	14	$\sqrt{28-28} = \sqrt{56} =$	7.5 =	1.9
TONAL MEMORY				
New England C. Group A	5	$\sqrt{30-10} = \sqrt{40} =$	6.3 =	1.3 larger than observed diff.
New England C. Group B	13.4	$\sqrt{30-36} = \sqrt{66} =$	8.1 =	1.6
Matthay School Group A	26	$\sqrt{2.5-10} = \sqrt{12.5} =$	3.5 =	7.4
Matthay School Group B	34.4	$\sqrt{2.5-36} = \sqrt{38.5} =$	6.2 =	5.5
Royal Academy Group A	2	$\sqrt{18.5-10} = \sqrt{28.5} =$	5.3 =	3.3 larger than observed diff.
Royal Academy Group B	10.4	$\sqrt{18.5-36} = \sqrt{54.5} =$	7.3 =	1.4

(1) Garrett, H.E., Statistics in Psychology and Education, p.129, formula 19.

TABLE XXXVIII

Summary of group comparisons, showing number of comparisons which are significant.

Pitch	Number of significant comparisons	Number of unsignificant comparisons
Pitch	4	2
Time	3	3
Consonance	3	6
Intensity	3	3
Tonal memory	2	4*

*Two comparisons are so low that chance alone would give a higher comparison between the groups.

SUMMARY

The tests of pitch, time, intensity, tonal memory, and consonance which have been standardized and recorded on Columbia phonograph records by Carl E. Seashore, were given to selected groups of musicians and to unselected groups of college students, and a comparison of scores was made between the two classified groups. In general there is a tendency for the musical groups to excel the non-musical ones but only in the test of pitch is the difference significant enough to show that it is measuring some aspect of musical talent, accurately enough to be of any practical value. The other tests, except rhythm which was not included in this study, are of doubtful value .

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Note:

(1) Used for source of all statistical formulae and methods of calculation.

(2) All of the article studied for relative material.

(3) Frequent reference method of procedure and to give directions for the tests.

(4) All of the book studied.

(5) This book not read.Reference from Guy M.Whipple, "Studies in Pitch Discrimination". Am.J.Psychol., 1903,14, p.303.